

## Economic Institutions of Russian Academic Science

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### Abstract

*In this paper, the basic provisions of the transactional theory of economic institutions of science are examined. It is shown that contemporary institutional theory of science determines the formation of economic and theoretical perspectives and applied methodologies for assessing the development of economic institutions. Results are presented from the authors' many years of empirical analysis of factors affecting Russian economic invention institutions, scientific publications and academic mobility.*

**Keywords:** *institutional theory, science, organisation of science, transaction costs.*

### 1. Introduction

Five Nobel Economics Prizes awarded for the development of institutional economics bear witness to the relevance of the institutional approach to economic research. In 1986, the Nobel Prize in Economics was won by John Buchanan for research on policy assessment as a process of exchange. His work led to the formation of the institutional theory of public choice. In 1991, the Prize in Economics was awarded to Ronald Coase for his work on "the institutional structure of production." In this work, he showed the possibility of assessing the institutional structure of the firm through a correlation of transaction costs and the type of organisation carrying out the activity – whether market-oriented or hierarchical. Douglass North won the Nobel Prize in 1993 for his assessment of economic activity over time. In 2007, the prize was awarded to Leonid Hurwicz, Eric Maskin, and Roger Myerson for their development of a theory of economic mechanisms. The mathematical foundation of the research consisted of a game theory based on a number of institutional principles. Thus, with the laureates the principle of the controller was introduced towards the implementation of agents of formal institutions and the principle of the focal point, which determines the convergence of actions with well-known rules. The 2009 Prize was awarded to Oliver Williamson and Elinor Ostrom for the development of the theory of economic organisation. Williamson is the author of the famous dependency of transaction costs on specific assets pertaining to an intermediate region between the firm and the market; these are identified and described in terms of network-centric organisations. Despite these impressive achievements, an essential sphere of human activity – scientific work – so far remains only in the initial stage of institutional analysis of its content.

Hence, the aim of this study was to review recent work on institutional description of the economic institutions of science with subsequent determination of impacts on key economic institutions of knowledge generation in the field of scientific activity.

### 2. Science as an Autonomous System

At the present time, science has achieved significant autonomy in relation to other areas of activity such that the "augmentation and transmission of scientific knowledge is the objective function of scientific activity, subject to the autonomy of science"<sup>1</sup>. Thus it is necessary to share the activities of generating inventions (creation of new knowledge) and innovative activity (introduction of new knowledge).

One of the first to draw attention to the distinction between inventions and innovations was Joseph Schumpeter. In

<sup>1</sup> Oleynik A.N. *Towards an institutional theory of science // Social studies and modernity. 2014. № 1. pp. 29-35: p. 30.*

his study entitled "The Theory of Economic Development" he noted that "new discoveries and inventions are constantly replenishing the existing stock of knowledge. [...] The functions of the inventor and the general technician do not coincide with the function of the entrepreneur. As such, the entrepreneur is not the spiritual creator of new combinations (*resources – E.P.*)"<sup>2</sup>.

According to Schumpeter, the implementation of new combinations by entrepreneurs includes the following five cases: "1) the production of new goods or the creation of a new quality of goods, 2) the introduction of a new mode of production, 3) the development of a new market, 4) the provision of a new source of raw materials, 5) the carrying out of an appropriate reorganisation"<sup>3</sup>. Thus, for Schumpeter, innovations (the first and second activities of an entrepreneur) precede inventions, i.e. the creation of new discoveries and patents.

The identification of inventions as the first phase of the innovation process is noted in studies by Russian scientists. Thus, it is noted that "innovative interaction occurs before the appearance of innovation – from the point at which inventions emerge – of new scientific and technical knowledge, the project of acquiring things that up to that point did not exist"<sup>4</sup>. And further: "A sign of the end of the invention phase is a completion of the transformation of knowledge into the product and the presence of monopoly rights over the result (either achieved by legal means or due to a temporary lack of competition due to the novelty of the products)"<sup>5</sup>.

Thus, the life cycle of scientific and technological activities consistently includes three phases: inventions (new knowledge, patents) – innovation (introduction of new knowledge) – imitation (replicating the introduction of new knowledge). Consequently, one can speak of invention institutions being established as norms of interaction between economic agents to generate new scientific knowledge as a result of fundamental and applied research<sup>6</sup>. In this case, the development of Schumpeter's ideas consists in the description of a three-phase cycle of institutional research activities<sup>7</sup>. From here opens the possibility of a division of scientific researchers into generators of knowledge, innovators and imitators of scientific achievements.

Another view of the functional division of scientists consists in separating the orientation of researchers to solve various problems. Thus to Burton Clark belongs the selection and justification of the three major orientations of university research activities<sup>8</sup>. The fundamental orientation of traditional universities implies service to its own academic ideals. The applied direction provided in business universities is focused on the implementation of ideas that have commercial potential, whereas the scientific work of the socially oriented higher education institute primarily implements objectives set by society and the State.

On the other hand, Nonaka and Takeuchi<sup>9</sup> as well as Lundvall and Borrás<sup>10</sup> have noted that the process of generation and application of knowledge requires a dynamic transformation of tacit and codified knowledge, as well as strong interactions of people both within organisations and between one organisation and another. If friction always applies to the transfer of codified knowledge with respect to time and distance, understood and applied tacit knowledge is embodied in people and organisations<sup>11</sup>.

In this connection, one should distinguish between two types of basic knowledge: analytical (scientific basis) and synthetic (engineering basis)<sup>12</sup>. These types reflect different ratios of implicit and explicit (codified) knowledge, designations of possibilities and limitations, qualifications and skills, requirements of organisations and institutions involved in specific innovation challenges and pressures from the globalised economy.

<sup>2</sup> Schumpeter J.A. *The Theory of Economic Development. Capitalism, Socialism and Democracy*. Trans. with M. Eksmo, 2008. p.158.

<sup>3</sup> Schumpeter J.A. *The Theory of Economic Development. Capitalism, Socialism and Democracy*. Trans. with M. Eksmo, 2008. pp.132-133.

<sup>4</sup> Rygalin D.B. *Systematisation of Problems and Identification of Trends Towards Sustainable Innovation Interactions // Creative Economy*. 2009. № 5. pp. 106-113: p. 108.

<sup>5</sup> Kortov S.V. *Management of Innovative Processes in a Region on the Basis of Evolutionary Modelling*. Diss. at soisk. ATLA. step. Dr. Econ. of Sciences. Ekaterinburg: IE Ural branch of the Russian Academy of Sciences, 2005. p. 60

<sup>6</sup> Popov E.V., Popov D.E. *Inventions as the Basis for Innovation // Problems of the Theory and Practice of Management*. 2013. № 2. pp. 101-108.

<sup>7</sup> Popov E.V., Vlasov M.V. *Economic Invention Institutions // Economic Analysis: Theory and Practice*. 2013. № 18. pp. 2-13.

<sup>8</sup> Clark B.R. *The Higher Education System: Academic Organization in Cross-National Perspective*. Berkley: University of California Press, 1983. p. 315

<sup>9</sup> Nonaka, I. and Takeuchi, H. *The Knowledge Creating Company*, Oxford – New York: Oxford University Press, 1995.

<sup>10</sup> Lundvall, B.-A. and Borrás, S., *The Globalising Learning Economy: Implications for Innovation Policy*, Luxembourg: European Communities, 1997.

<sup>11</sup> Nightingale, P. *A Cognitive Model of Innovation // Research Policy*, 1998, 27, 689-709.

<sup>12</sup> Laestadius, S. *Technology Level, Knowledge Formation and Industrial Competence in Paper Manufacturing*, in G. Eliasson and C. Green (eds.), *The Micro Foundations of Economic Growth*, Ann Arbor: The University of Michigan Press, 1998. pp. 212-226

The basis of analytical expertise corresponds to the position of industry, where scientific knowledge is very important and where the generation of knowledge is often based on cognitive and rational processes, or on formal models. Examples include genetics, biotechnology and information technology. The basis of analytical expertise is more codified than the other type of knowledge. Codification is increasingly used for the following reasons: the emergence of knowledge often based on existing studies; the generation of knowledge based on the application of scientific principles and methods; the process of transmission of knowledge more formally organised (e.g., R&D units); and the output of knowledge generation documented in the reports, electronic files and patents.

The basis of synthetic knowledge corresponds to the position of industry where innovations play a major role through the use of existing knowledge or new combinations of knowledge. Often this takes the form of a solution to a specific problem faced by buyers and their suppliers. Here, studies are of less importance than in the analytical type of knowledge. For synthetic knowledge, applied research is required, often in the form of products or processes<sup>13</sup>.

Thus, science as an autonomous economic system can be represented by a wide variety of functional researcher roles.

### 3. Scientific Transactions and Transaction Costs

The first economist to focus conceptually on non-production interactions between economic agents was John Commons<sup>14</sup>, who proposed the transaction as the basic unit of economic activity analysis. According to his ideas, transactions are the "alienation and acquisition, between individuals, of the rights of property and liberty created by society". As noted by Commons: "The ultimate unit of activity [...] must contain in itself the principles of conflict, mutuality and order. This unit is a transaction"<sup>15</sup>.

The most detailed definition of the transaction was provided by Oliver Williamson as follows: "A transaction is the transfer of goods or services from the final point of one process to the starting point of another, adjacent to the first one. It is the end of one stage of activity and the beginning of another"<sup>16</sup>.

As noted by Victor Martins-da-Rocha and Yiannis Vailakis, transaction search, transportation, storage and measurement information comprise the major endogenous transactions even in the traditional markets such as financial markets<sup>17</sup>.

However, according to a broad study of the literature made by Aric Rindfleisch et al<sup>18</sup>, it is shown that the study of transaction type is one of the most promising areas within the contemporary field. How, then, can the transactions of economic agents be systematised? The answer to this question can be obtained by referring to the concept of the market potential of the enterprise<sup>19</sup>, demonstrating a variety of transactions at the level of a business entity.

The market potential comprises the sum total of tools and capabilities available to the enterprise in the realisation of its market activity. The institutional nature of the market potential of the company is to structure established norms of interaction between economic agents, designed in such a way as to best realise its market activities.

Analysis of the structure of the market potential of the company shows that non-production activity should be included amongst the transactions of economic agents – namely, analytical and communication activities (if they are not the main production processes of the economic agent). Assuming that the analytical work includes searching for information and market analysis (search for buyers), and communication – promotion of goods, protection of property rights and protection from opportunism, the principal types of transactions of manufacturing enterprises can be divided into five transaction types. These comprise the following<sup>20</sup>: 1) information retrieval; 2) market analysis; 3) protection of property rights; 4) protection against opportunism; 5) promotion of products.

The typology of transactions permits a shift to economic institutions that support well-established norms of

<sup>13</sup> Asheim B.T. and Coehen L. *Contextualising Regional Innovation Systems in a Globalising Learning Economy* //Journal of Technology Transfer. 2006. Vol. 31. pp. 163-173.

<sup>14</sup> Commons J.R. *Institutional Economics* //American Economic Review. 1931. Vol. 21. N 4. pp. 649-672.

<sup>15</sup> Commons J.R. *The Problem of Correlating Law, Economics and Ethics* //Wisconsin Law Review. 1932. Vol. 8. pp. 3-26: pp. 4.

<sup>16</sup> Williamson O.E. *Transaction-Cost Economics: The Governance of Contractual Relations* //Journal of Law and Economics. 1979. Vol. 22. pp. 233-261: pp. 235.

<sup>17</sup> Martins-da-Rocha V.F., Vailakis Y. *Financial Markets with Endogenous Transaction Costs* //Economic Theory. 2010. Vol. 45. pp. 65-97: pp. 68.

<sup>18</sup> Rindfleisch A., et al. *Transaction Costs, Opportunism and Governance: Contextual Considerations and Future Research Opportunities* //Market Letters, 2010. Vol. 21. pp. 211-222.

<sup>19</sup> Popov E.V. *Market Potential of the Firm* //International Advances in Economic Research. 2004. Vol. 10. N 4. pp. 337-338.

<sup>20</sup> Popov E.V. *Transactions & Institutions* //Montenegrin Journal of Economics, 2012. Vol. 8, N 2, pp. 115-125.

interaction between economic agents<sup>21</sup> and an evaluation of the transaction sector of the economy.

When speaking of the Ural school of institutional studies, it is necessary first of all to note the development of the transactional theory of economic institutions<sup>22</sup>. The principal content of the theory consists in the quantification of the quality of institutions through the evaluation of economic transactions.

The transactional theory of economic institutions is based on the following scientific principles:

- boundedness of transactions according to John Commons<sup>23</sup>,
- formation of the transactional sector according to John Wallis and Douglas North<sup>24</sup>,
- non-production nature of transaction costs according to Robert Matthews<sup>25</sup>,
- proportionalities of asset-specific transaction costs according to Oliver Williamson<sup>26</sup>.
- minimisation of transactions in the formation of economic institutions according to Ronald Coase<sup>27</sup>.

Scientific ideas are advanced in terms of the authors' original theoretical development on the typology of transactions, the valuation of crises, the definition of transaction costs on financial statements<sup>28</sup>, the assessment of the closeness of ties between hybrid organisations and the valuation of economic institutions according to transaction costs<sup>29</sup>.

In discussing scientific transactions, it is advisable to locate the resource indicators of differentiation of knowledge according to the degree of their impact on the informational, human and material resources of the organisation. The transactional view of the evolution of economic institutions in determining the differentiation of knowledge resource indicators lies in identifying the difference between the dynamics of change in transaction costs required for the formation and maintenance of various institutions that generate operational, structural and functional knowledge<sup>30</sup>.

The development of an institutional approach to the assessment of scientific activity permits the design of institutional atlases<sup>31</sup> and an evaluation of the transaction costs of scientific productivity<sup>32</sup>.

The economic literature widely used classification of transaction costs by Thrainn Eggertsson<sup>33</sup> and Andrey Nesterenko<sup>34</sup>. However, the classification of transaction costs developed by the authors of the present study enables a simulation of the dynamics of their development<sup>35</sup>.

An important achievement in the institutional analysis of scientific activities relates to the formation of methods of allocation of transaction costs in the financial statements of academic institutions<sup>36</sup>. It is shown that, in addition to scientific production activities, academic organisations also carry out transactional activities. These include: publishing, information and library/software research, the organisation of scientific conferences and participation in conferences, advertising and exhibition activities, the implementation of international relations, legal activities and the formation of public opinion. On this basis, transaction costs can be systematised in respect of items of financial statements<sup>37</sup>.

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<sup>21</sup> Popov E.V., Sergeev A.M. *Contemporary Russian Institutionalism: Towards a Continuation of Discussions* // *Problems of Economics*. 2010. № 2. pp. 103-116.

<sup>22</sup> Popov E.V. *Transaction Estimation of Institutions* // *Advances in Economics and Business*. 2014. Vol. 2. N 1. pp. 58-64.

<sup>23</sup> Commons J.R. *Institutional Economics* // *American Economic Review*. 1931. Vol. 21. N 4. pp. 649-672: pp. 652.

<sup>24</sup> Wallis J., North D. *Measuring the Transaction Sector in the American Economy, 1870-1970* // *Long-Term Factors in American Economic Growth*, Ed. by S. L. Engerman and R.E. Gallman. Chicago; University of Chicago Press, 1986. pp. 95-148.

<sup>25</sup> Matthews RCO *The Economics of Institutions and Sources of Growth* // *Economic Journal*. 1986. Vol. 96. N 12. pp. 903-910.

<sup>26</sup> Williamson O.E. *Strategizing, Economizing and Economic Organization* // *Strategic Management Journal*. 1991. Vol. 12. N 1, pp. 75-94.

<sup>27</sup> Coase R.H. *The Nature of Firm* // *Economica*, 1937, Vol. 4. N 10. pp. 386-405.

<sup>28</sup> Popov E.V., Vlasov M.V., Veretenikova A.Y. *Knowledge Generation Within a Firm as an Object of Institutional Design* // *Actual Problems of Economics*. 2013. No 1. pp. 463-478.

<sup>29</sup> Popov E.V. *The Transaction Theory of Institutions* // *Proceedings of the 11<sup>th</sup> Eurasia Business and Economics Society Conference* (Ekaterinburg, 12-14 September 2013). Turkey, Istanbul: EBES, 2013. pp. 765-776.

<sup>30</sup> Popov E.V., Vlasov M.V. *Resource Differentiation of Knowledge* // *Business*. 2011. Vol. 3. N 2. pp. 211-217.

<sup>31</sup> Popov E.V. *Institutional Atlas* // *Atlantic Economic Journal*. 2011. Vol. 39. N 4. pp. 445-446.

<sup>32</sup> Popov E.V. & Vlasov M.V. *Transaction Costs for Research Productivity* // *International Journal of Business and Management*. 2013. Vol. 8. N 2. pp. 78-85.

<sup>33</sup> Eggertsson T. *Economic Behaviour and Institutions*. Cambridge: Cambridge University Press. 1990. 408 p.

<sup>34</sup> Nesterenko A.N. *Economy and Institutional Theory*. M.: Editorial URSS, 2002.

<sup>35</sup> Popov E.V. *Diffusion Model of Transaction Cost Dynamics* // *Journal of Economics and Business*. 2011. Vol. 2. N 3. pp. 222-229.

<sup>36</sup> Popov E.V. and Vlasov M.V. *Research Productivity Dependence on Transaction Costs* // *Proceedings of the 13<sup>th</sup> European Conference of Knowledge Economy*. University of Cartagena, Spain: Academic Publishing Ltd, 2012. pp 967-974.

<sup>37</sup> Popov E.V., Vlasov M.V., Orlova N.V. *Transaction Costs Generate Explicit Knowledge of an Academic Institution* // *Management in Russia and Abroad*. 2011. № 1. pp. 107-115.

#### 4. Economic Institutions of Inventions

The phenomenon of the transformation of knowledge into the primary productive force was predicted in the 1960-70s in the works of Peter Drucker, Daniel Bell and Alvin Toffler<sup>38</sup>. The competitive advantages of the firm began to be interpreted in relation to the ability to benefit from the electronic resources of the Internet and e-commerce, to attract and retain "knowledge workers" and create a "learning organisation"<sup>39</sup>. It is no coincidence that one of the most fruitful achievements of strategic management theorists in recent years, formed on the basis of the resource approach, has been the concept of the "knowledge-creating company"<sup>40</sup> and development that proceeds according to the intellectual capital of the firm.

All economic activities of business entities are put into effect in accordance with various institutions. On the one hand, the charter, job descriptions and other formal documents supporting the creation and processing of raw materials for a new product or service; that is, economic institutions, emerging and functioning in the process of changing the resources of an economic entity and whose valuation may be expressed in terms of transformation costs. At the same time, for the activities to create new value and facilitate their market implementation, different operations are required when undergoing a change of ownership, which arise in the processes and functioning of institutions, the valuation of which can be assessed in terms of transaction costs<sup>41</sup>.

In his monograph "Elements of Reform Theory", V.M. Polterovich identifies several stages in the development of innovations in industrial enterprises: borrowing, i.e. the acquisition (purchase) of new knowledge; copying (the duplication of knowledge created by other companies); imitation and pioneering research and development<sup>42</sup>. By analogy, in order to facilitate the development of the process of creating new values in industrial enterprises, invention institutions can be classified as follows: institutions of borrowing, copying, imitation and generation.

To identify patterns in processes involved in controlling inventions, the Institute of Economics of UB RAS carried out a series of group interviews in 2014 with the heads of medium-sized industrial enterprises located in the Sverdlovsk region. A distinctive feature of these companies is that the primary activity is high-tech processing of raw materials in the process of creating new values.

In terms of carrying out activities relating to inventions, 78% of surveyed companies plan to use inventions in the form of borrowing in the short term up to 1 year (Table 1).

**Table 1:** The distribution of various types of inventions depending on the planning horizon (per cent)

Type of Invention	Planning Horizon			
	up to 1 year	1-3 years	3-5 years	>5 years
Borrowing	78	21	6	2
Copying	11	59	12	7
Imitation	8	12	56	10
Generation	3	8	28	81
Total	100	100	100	100

This change planning horizon has been chosen because this type of invention is not developed directly by business entities but purchased on the open market; thus, it quickly becomes obsolete and loses its value. For the copying and imitation of inventions, the planning horizon increases by an average of 2-3 years (59% of copying inventions coincides with a planning horizon of 1-3 years). The most distant planning horizon is applied when inventions having no analogues are generated directly by an economic entity (in 81% of cases the generation of inventions has a planning horizon of more than 5 years).

The results showed that in 75% of cases when changing information resources, the relevant inventions are not generated by the enterprises themselves, but are rather borrowed (purchasing borrowed inventions on the open market);

<sup>38</sup> Drucker P. F. *The Theory of the Business*//Harvard Business Review. 1994. Sept.-Oct.; Bell D. *The Coming of Post-Industrial Society: A Venture of Social Forecasting*. - NY:Basic Books, 1973; Toffler E. *Third wave-M* .:ACT, 2010.

<sup>39</sup> Katkalo V.S. *Strategic Management Theory: Stages of Development and the Basic Paradigm* // Bulletin of Saint Petersburg State University. 2002. Ser. 8. Vol. 3. (24). pp. 3-26.

<sup>40</sup> Nonaka and Takeuchi. *The company is the creator of knowledge. The origin and development of innovations in Japanese firms. M.: Olympus Business*. - 2003

<sup>41</sup> Popov E.V. *Transactional Theory of Institutions* // Economic Analysis: Theory and Practice. 2013. № 27. pp. 2-12.

<sup>42</sup>Polterovich V.M. *Elements of Reform Theory*. M.: Economics. 2007 - 445p.



in 12% of cases they are copied from other enterprises; and only in 4% of cases is the new knowledge developed by themselves, i.e. generated (Table. 2). Consequently, when changing the information resources of the enterprise, the most significant are the institutions of borrowing inventions.

**Table 2:** Distribution of generation of inventions while varying the type of enterprise resource (per cent)

Type of Invention	Type of Resource		
	Informational	Organisational	Material
Borrowing	75	16	4
Copying	12	38	7
Imitation	9	34	12
Generation	4	12	77
Total	100	100	100

When making changes in the organisational structure, the most important in the studied companies are: copying of inventions (38% of cases) and imitation of inventions (34% of cases). When changing the organisational structure, independent enterprises generate inventions in an average of 12% of cases. Consequently, when changing the organisational-structural resources of the enterprise, the most significant are the institutions of copying and imitating inventions.

When asked about the importance of the various kinds of inventions by changes in fixed assets of enterprises, the answers were distributed as follows: use of generation of inventions – in 77 cases out of 100; other types of inventions – in 23 cases. That is, when changing the fixed assets of enterprises, the most important institutions are those that generate inventions.

Consequently, the following patterns of institutional cycles of inventions in industrial enterprises are revealed:

- the planning horizons for changes and invention cycles widespread throughout the enterprise are interrelated: for the generation of new knowledge, a "long" time horizon is required and "long" life cycle institutions generate inventions, whereas the short life cycle of institutions of borrowing inventions coincides with the short life cycle of the respective inventions, bringing about changes in the information resources of the enterprise;
- when changing the information resources of the enterprise, the most important are the institutions of borrowing inventions;
- when changing the organisational-structural resources of the enterprise, the most significant are the institutions of copying and imitating inventions;
- institutions generating inventions are used primarily to change the basic (material) resources of the enterprise.

In connection with the invention institutions of manufacturing companies, the authors have developed a model of institutional knowledge generation based on the principles of project management, which includes an analysis of the institutional environment, a statement of problem, goals and objectives of institutional design, institutional project development (based on the design principles of V. Tambovtsev), the implementation of the institutional project and its adjustment as well as monitoring of the functioning of the institutional environment. The novelty of this institutional design model of knowledge generation is an extended arsenal of methodological tools for institutional design in the economic sphere of science<sup>43</sup>.

## 5. Economic Institutions of Publication Activity

One major activity of scientific institutions is the activity of publication. Factors of influence on the development of these institutions can be both competitive (grant) funding as well as the dynamics of changes in transaction costs. Working hypotheses for empirical research were formulated on the basis of the results obtained by the authors of the present paper in previous studies and a dataset available for the analysis.

Within the analysed dataset the size of the financing of various competitions of basic research in the context of various scientific fields is included as an independent variable. The number of published articles on the results of projects in various competitions of scientific works is included as the dependent variable.

The first two hypotheses are quite obvious, serving to establish a relationship between the number of published

<sup>43</sup> Popov T.V., Vlasov M.V., Veretenikova A.Y. *Knowledge Generation within a Firm as an Object of Institutional Design //Actual Problems of Economics*. 2013. N 1. pp. 463-478.

papers and initial project funding received.

**Hypothesis 1:** The proportion of published articles (of the total number of published articles) on the results of fundamental research is directly proportional to the allocation of funding of specified research programmes on a competitive basis.

**Hypothesis 2:** The proportion of published articles on the results of fundamental research is directly proportional to the allocation of funding to independently defined research projects on a competitive basis.

Specified research programmes were classified as projects carried out according to the particular scientific fields or scientific problems. The second hypothesis is distinguished from the first due to the research objectives being determined by the authors of the projects themselves when assessing the publication activity of such projects.

The third hypothesis may also be considered obvious; however, its quantitative content is not trivial.

**Hypothesis 3:** The rate of increase in publication activity as a result of fundamental research varies with funding granted according to various competitive criteria. It can be assumed that the growth rate of publications is proportional to the scientific novelty of the problems selected.

The third hypothesis is connected to the likelihood that the research objectives may vary from one competitive context to the next: from solving conventional research task to carrying out creative exploratory studies. The determination of traditional problems is prior to the implementation of an exploratory research initiative in a specified research programme.

To test the working hypotheses, data on the results of basic research conducted in 2012 in research organisations of one of the regional offices of the Russian Academy of Sciences, which receives appropriate funding on a competitive basis, was analysed.

Data from several dozen research organisations participating in the specified research programmes (programmes of the Presidium of Russian Academy of Sciences and Russian Academy of Sciences thematic departments) was analysed, as well as competitive tenders of scientific project initiatives.

To ensure comparability of the data, normalisation of funding and number of published articles on the total volume of funding and the total number of corresponding articles in a specific field was carried out. As a result, a dataset was obtained in the form of the relative proportion of funding and the relative proportion of publication activity in the aggregated data.

To test the first hypothesis, the proportion of published scientific articles was compared to the set of fundamental research programmes and their contribution to total funding for the respective competitions (Table. 3)

**Table 3.** The dependency of the publication activity on financing in respect of the competitive programme of fundamental research

Programme Types  indicators  Field of Science	RAS Presidium Programme		Thematic programmes of RAS branches	
	Proportion of Financing, %	Proportion of published articles, %	Proportion of Financing, %	Proportion of published articles, %
Mathematics	14.9	22.1	25.8	24.6
Physics	26.3	22.2	30.4	24.7
Chemistry	14.9	11.5	23.2	23.9
Biology	21.2	22.7	3.6	3.7
Earth Sciences	13.8	15.3	13.7	17.9
Economics	3.1	2.0	-	-
Humanities	2.8	4.2	3.3	4.2

The data presented in Table 3 show convincing proof of the first hypothesis of a direct proportional share of articles published on the results of fundamental research on the share won by competitive funding for specified research programmes.

To test the second hypothesis, the proportion of published scientific articles was compared according to the results of fundamental research from the proportion of the total funding allocated for competition of independently defined research projects (Table. 4)

The data presented in Table 4 show convincing proof of the second hypothesis of a direct proportional dependency of published articles on the results of fundamental research allocated competitive funding to independently defined research projects.

**Table 4.** Dependency of publication activity on funding for independently defined scientific projects (per cent)

Indicators	Proportion of funding %	Proportion of published articles, %
Field of Science		
Mathematics	6.6	4.7
Physics	30.4	24.4
Chemistry	7.0	9.7
Biology	23.3	18.7
Earth Sciences	29.2	36.0
Economics	2.3	2.8
Humanities	1.2	3.7

To verify the third hypothesis, a graph of publication activity on the share of funding for competition of specified research projects was constructed, consisting of programmes of the Presidium of the Russian Academy of Sciences, thematic programmes of RAS Branches, as well as the independently defined research projects funded by competition. The analysis demonstrates the validity of the third hypothesis showing that the growth rate of publication activity on the results of fundamental research varies according to funding by various competitions.

In this connection, the lowest publications growth rate  $dN$  from changes in funding  $dK$  occurs with the competitive projects of the programme of the Presidium of Russian Academy of Sciences ( $dN/dK = 0.906$ ), and the highest rate occurs with projects under the programmes of the thematic departments of the RAS ( $dN/dK = 1.092$ ). Publication activity in the performance of independently defined research projects occupies an intermediate position between the two previously mentioned cases ( $dN/dK = 0.956$ ).

Apparently, this result can be explained by the greater riskiness of positive results in solving problems of the Presidium of the Russian Academy of Sciences. Increased preparation time for models and experiments leads to a reduction in the available time for preparing scientific publications. It should be noted that the conclusion about the high volatility of the fundamental results of the competition programme of the Presidium of Russian Academy of Sciences corresponds to an increased scatter in the data resulting from these competitions, obtained during the verification of the first hypothesis<sup>44</sup>.

The results of earlier studies have shown that increasing the proportion of young employees of the scientific organisation by 1% with an increase in transaction costs by 1% increases the publication activity of all institutions by 7%<sup>45</sup>.

The overall result of the impact of young people on scientific productivity is also confirmed by the measurement of publication activity according to the number of published articles rather than the volume of publications.

An interesting discussion concerns the distinct dynamics of publication activity for Russian and foreign journals. Here the situation is not entirely unambiguous. However, even in this case, the proportion of young scientists in the surveyed institutions is directly proportional to the dynamics of scientific activity in the publication of articles in Russian journals. The same dependency on the dynamics of the publication of articles in international journals corresponds to the proportion of mature scientists in academic institutions.

The obtained dependences can be explained by the fact that, in an effort to quickly obtain scientific prestige, young scientists focus to a greater extent on the publication of articles in more accessible Russian journals. The preparation and transmittal of articles in foreign journals, on the other hand, requires the experience and knowledge of mature researchers. Therefore, an increase in the proportion of mature scientists leads to exacerbated dynamics from the impact of additional transaction costs of publication activity in foreign scientific press.

## 6. Scientific Mobility of Economic Institutions

The dynamics of the mobility of scientific researchers can be similarly analysed. By the dynamic mobility of scientists is understood a specific, empirically determined, exponential dependency of changes in the number of conference papers to changes in transaction costs of academic institutions. Table 5 presents the exponents of the experimental dependences for similar institutions in the natural sciences, differing only by the proportion of young researchers (the largest proportion

<sup>44</sup> Popov E.V., Vlasov M.V., Schastlivtseva E.V. *Competitive Research Funding // Economic Analysis*. 2014. № 22. pp. 2-8.

<sup>45</sup> Popov E.V., Vlasov M.V. *Dependence of Research Productivity on Transaction Costs // Actual Problems of Economics*. 2012. N 5. pp. 427-437.



of young researchers in the first establishment and the lowest in the fourth).

The empirical relationships obtained do not show a causal link between the proportion of young employees and the mobility of scientists. However, some trends can still be identified<sup>46</sup>.

As the table shows, a decrease in the proportion of young scientists from the second to the fourth institution will decrease the dynamics of mobility of researchers according to changes in transaction costs.

**Table 5.** The exponents of the dynamics of the mobility of scientists on changes in transaction costs (in the number of conference papers)

Name of institution	Exponential indicators		
	All conference papers	Russian conference papers	International conference papers
First institution	0.56	0.31	2.67
Second institution	0.92	0.95	0.57
Third institution	0.40	1.12	-0.07
Fourth institution	0.28	0.26	0.30

Thus, an increase of 1% in the proportion of young employees with a 1% increase in transaction costs can increase the mobility of all scientific academic institutions by more than 10%. This is the maximum score obtained from a comparison of the second and fourth institutions, but it helps an understanding of the impact of young scientists participating in conferences. In other words, an increase in the number of young scientists is a reliable scientific basis for the development of mobility with the appearance of additional transaction costs relating primarily to travel expenses and organisational contributions to conferences.

However, the dynamics of academic mobility in relation to participation in the Russian conferences increases with the proportion of mature scientists (from the first to the third institution). Apparently, this fact testifies to the traditions and experience of participation of mature scientists in Russian conferences, as well as the wide range of possibilities for such participation for mature employees of the Academy of Sciences.

On the other hand, in accordance with empirical data, an increase in the proportion of young employees from the third to the first institution sharply increased the mobility of scientists participating in international conferences. The explanation for this phenomenon lies in the desire of young scientists to quickly conquer a more attainable "scientific Olympus" compared with the approach of mature scientists to participation in international conferences, including participation facilitated by a deeper knowledge of foreign languages.

However, publication activity – and, to a greater degree, the academic mobility of scientists – is determined by transaction costs. How, then, can transaction costs be reduced (and, for example, the publication activity and academic mobility of researchers continue to be maintained)? The answer to this question lies in a consideration of the transactional function. An analytical view of the transactional function shows a reduction of transaction costs in the formation of well-established rules of economic activity<sup>47</sup>.

Reducing transaction costs of publication activity will occur in the case of a well-established list of academic journals and stable requirements for the publication of scientific articles. In this situation, the costs to the researcher of searching for information related to the publication of research material will be kept to a minimum value.

Reducing the transaction costs of academic mobility will take place during the formation of a well-established list of scientific conferences and stable requirements for participation in these conferences. In this case, the cost of travel expenses and organisational contributions can be kept to a minimum value, for example, due to more early booking of tickets and hotels, as well as an earlier (and economical) payment of a registration fee.

The main conclusion of the review of the transactional function states that the institutional design and structuring of creative activity can lead to savings of transaction costs, and, consequently, to increase the impact of scientific institutional publication activity and the mobility of scientists.

It should be noted that similar results were obtained for universities. Thus, according to the financial statements, the hypothesis concerning the dependence of the dynamics of invention institutions on the dynamics of changes of transaction costs on the publication activity and scientific mobility is empirically proved<sup>48</sup>. An analysis of the financial

<sup>46</sup> Popov E.V., Vlasov M.V. *The Mobility of Young Scientists // Economic Analysis: Theory and Practice*. 2012. № 3. pp. 43-52.

<sup>47</sup> Popov E.V. *Transaction Function of the Firm //Chapter 8. In "Progress in Economic Research". Vol. 25. Ed. A. Tavidze. N.Y.: Nova Science Publishers, 2012. pp. 177-186.*

<sup>48</sup> Popov E.V. and Vlasov M.V. *Managing Knowledge Generation at Universities //Proceedings of the 15th European Conference on Knowledge Management. Portugal: Santarem University. 2014. vol. 2. pp. 811-816.*

statements of one of the natural divisions of federal universities reliably identified three dependencies. First, an increase in the generation of knowledge in the form of the publication of articles and participation in conferences is directly proportional to the growth of transaction costs relating to research activities. Second, the transaction rate of generation of knowledge in the form of exponential participation in exhibitions (the derivative function of the number of exhibits on transaction costs) is proportional to the number of business entities created by the analysed subdivisions of the university. Third, the transaction rate of generation of knowledge in the form of research reports is proportional to the volume of extra-budgetary burden on university staff. The scientific novelty of the proof of the dependency of the dynamics of invention institutions on the dynamics of changes in transaction costs is to build an adequate institutional approach to the analysis of publication activity and scientific mobility.

The allocation of transaction costs from financial statements would introduce a transactional rate of the growth of knowledge that characterises the susceptibility of effective knowledge generation to changes in the relevant transaction costs. The authors' concept of a transactional rate of knowledge generation develops the theoretical and methodological position of the transactional theory of economic institutions in the economic sphere of science<sup>49</sup>.

To increase the effectiveness of research activities in the university sector of science, it is first necessary to increase funding for travel costs of professors and students to participate in scientific activities. A direct correlation between the dynamics of financing the costs of knowledge generation and scientific activity has been identified. An increase in transaction costs provides an increase in scientific output in the scientific university sector<sup>50</sup>.

## 7. Conclusion

Consequently, this review of recent work on the institutional description of the economic institutions of science with subsequent determination of impacts on key economic institutions of knowledge generation in the field of scientific activity have allowed the following theoretical and applied results.

It is shown that scientific activity is an autonomous system with different functional content in terms of structure of researchers. Therefore, there is the possibility of a division of workers in scientific research into generators of knowledge, innovators and imitators of scientific achievements. It follows that one should distinguish between two bases of knowledge: the analytical (scientific basis) and the synthetic (engineering basis).

The transactional theory of economic institutions includes the principles of boundedness of transactional activities, the formation of the transaction sector and the non-production nature of transaction costs – these costs being proportional to asset specificity – and a minimisation of the transaction as a consequence of the formation of institutions imposed by the founders of this theory.

The scientific ideas of the typology of transactions, assessment of crises, determination of transaction costs from accounting, estimations of the closeness of the connections of hybrid organisations and cost evaluation of economic institutes for transaction expenses can be advanced as bases for planning further scientific research in a deepening of the transaction theory of institutions.

The allocation of transaction costs from financial statements would introduce a transactional rate to the growth of knowledge that characterises the susceptibility of effective knowledge generation to changes in the relevant transaction costs.

The obtained empirical results allow various factors to be classified, such as the kinds of competitive financing, changes in transaction costs of searching for information and the promotion of scientific production, that significantly affect the dynamics of economic invention institutions, publication activity and academic mobility.

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<sup>49</sup> Popov E.V., Vlasov M.V. Veretennikova A.Y. *Institutional Design of Knowledge Generation in Business Entities // Journal of Economic Theory*. 2012. № 3. pp. 71-84.

<sup>50</sup> Popov E.V., Vlasov M.V. *The Scientific Impact of the University//FES: Finance, Economics, Strategy*. 2012. № 5. pp. 9-14.